CBCS SCHEME

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18EC55

Fifth Semester B.E. Degree Examination, Feb./Mar. 2022
Electromagnetic Waves

Time: 3 hrs. Max. Marks: 100

Note: ***Answer any FIVE full questions, choosing ONE full question from each module.***

Module-1

1 a. State and explain Coulomb's Law. Also express in Vector form. **(06 Marks)**

b. Derive the expression for electric field intensity due to infinite line charges. **(08 Marks)**

c. Find the electric field at a point P(2, 15, 13)m due to the uniform line charge density ρ_L = 25nc. Given that a perpendicular to drawn from A meets the line charge at a point B(3, 0, 4)m. **(06 Marks)**

OR

2 a. A charge $Q_2 = 121 \times 10^{-9}$ C is located in free space at P_2(-0.03, 0.01, 0.04)m. Find the force on Q_2 due to Q_1 where $Q_1 = 110 \times 10^{-6}$C at P_1 (0.03, 0.08, -0.02)m. **(06 Marks)**

b. Define Electric Field Intensity. Derive the expression for Electric field at a point due to may charges. **(08 Marks)**

c. Derive the expression for field due to continuous volume charge distribution. **(06 Marks)**

Module-2

3 a. State and explain Gauss Law. **(06 Marks)**

b. Evaluate both sides of divergence theorem for the field D = $2xy\overline{ax} + x^2\overline{ay}$ c/m^2 and the rectangular parallel piped formed by the planes x = 0 and y = 1, y = 0 and y = 2, z = 0 and 3. **(10 Marks)**

c. Show that electric field intensity is negative potential gradient. **(04 Marks)**

OR

4 a. Obtain the expression for the work done in moving a point charge in an electric field. **(06 Marks)**

b. Derive the expression for equation of continuity. **(08 Marks)**

c. Give $V = 2x^2y - 5z$ at point P(-4, 3, 6). Find the potential, electric field intensity and volume charge density. **(06 Marks)**

Module-3

5 a. Solve the Laplace's equation to find the potential field in the homogeneous region between the two concentric conducting sphere with radii a and b such that b > a. If potential V = 0 at r = b and $V = V_o$ at r = a. Also find Electric field intensity. **(10 Marks)**

b. If the magnetic field intensity in a region is H = (3y – 2)az + 2 ×ay. Find the current density at the origin. **(04 Marks)**

c. State and explain Biot – Savart's law. **(06 Marks)**

OR

6 a. State and prove Uniqueness theory. **(08 Marks)**

b. Determine whether or not the following potential fields satisfy the Laplace's equation.
i) $V = x^2 - y^2 + z^2$ ii) $V = r\cos\phi + z$. **(08 Marks)**

c. Explain the concepts of Scalar Potential. **(04 Marks)**

Module-4

7 a. Derive an expression for force between differential current elements. **(06 Marks)**

b. Obtain the boundary conditions at the interface between two magnetic materials. **(10 Marks)**

c. Find the magnetization in a magnetic material, where

i) $\mu = 1.8 \times 10^{-5}$ H/m and H = 120 A/m ii) B = 300μT and suspectibility = 15. **(04 Marks)**

OR

8 a. State and explain Faraday's law of Electromagnetic Induction. Show its equation in differential form and integral form. **(10 Marks)**

b. A point charge Q = 18nc has a velocity of 5 × 106 m/s in the direction $a_v = 0.6\overline{a}_x + 0.75\overline{a}_y + 0.3\overline{a}_z$. Calculate the magnitude of force exerted on the charge by the field i) $\overline{E} = -3\overline{a}_x + 4\overline{a}_y + 6\overline{a}_z$ Kv/m ii) $\overline{B} = -3a_x + 4\overline{a}_y + 6\overline{a}_z$ MT

iii) $\overline{B}$ and $\overline{E}$ acting together. **(06 Marks)**

c. A conductor of length 4m long lies along the Y – axis with a current of 10 Amp in the $\overline{a}_y$ direction. Find the force on the conductor if the field in the region is B = $0.005\overline{a}_x$ tesla. **(04 Marks)**

Module-5

9 a. What is meant by Uniform Plane Wave? Derive the expression for Uniform Plane Wave in the free space. **(10 Marks)**

b. Let $\mu = 10^{-5}$H/m, $\epsilon = 4 \times 10^{-9}$F/m, $\sigma = 0$ and $\rho_v = 0$. Determine 'K' so that each of the following pair of fields satisfies Maxwell's equation :

i) $\vec{D} = 2x\hat{a}_x - 3y\hat{a}_y + 4z\hat{a}_z\ nC/m^2$, $\vec{H} = Kx\hat{a}_x + 10y\hat{a}_y - 25z\hat{a}_z\ A/m$

ii) $\vec{E} = (20y - kt)\hat{a}_x\ V/m$, $\vec{H} = (y + 2\times10^6 t)\hat{a}_z\ A/m$. **(10 Marks)**

OR

10 a. State and explain Poynting's theorem. **(10 Marks)**

b. Discuss Wave propagation in good conducting medium. **(06 Marks)**

c. Find the frequency at which conduction current density and displacement current density are equal in a medium with $\sigma = 2 \times 10^{-4}$ ℧/m and $\varepsilon_r = 81$. **(04 Marks)**

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